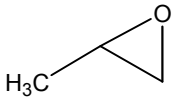
PROPYLENE OXIDE
CAS No. 75-56-9
First Listed in the *Sixth Annual Report on Carcinogens*



CARCINOGENICITY

Propylene oxide is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (NTP 267, 1984; IARC V.36, 1985; IARC S.7, 1989). When administered by inhalation, the compound induced hemangiomas or hemangiosarcomas of the nasal cavity in mice of both sexes. When administered by inhalation, propylene oxide increased the incidences of papillary adenomas of the nasal turbinates in rats of both sexes (NTP 267, 1984). When administered by inhalation to male weanling rats, the compound increased the incidences of adrenal pheochromocytomas and peritoneal mesotheliomas. When administered by gavage to female rats, propylene oxide produced a dose-dependent increase in the incidence of local tumors, mainly squamous cell carcinomas of the forestomach. When administered by subcutaneous injection to female mice, the compound increased the incidence of local tumors, mainly fibrosarcomas (IARC V.36, 1985; IARC S.7, 1987).

There are no data available to evaluate the carcinogenicity of propylene oxide in humans (IARC V.36, 1985; IARC S.7, 1987).

PROPERTIES

Propylene oxide is a volatile, clear, colorless, extremely flammable liquid with an ether-like odor. It is soluble, but also decomposes in water. It is also soluble in alcohol, and ether and miscible with most organic solvents. When exposed to flame, propylene oxide can explode. It polymerizes and reacts with compounds having labile hydrogen. It also reacts with acids, bases, oxidizing agents, copper and copper alloys.

USE

Propylene oxide is used mainly as a chemical intermediate in the production of polyurethane polyols (60% of the propylene oxide produced), which are then used to make polyurethane foams, coatings, and adhesives. Propylene oxide is used in the manufacture of propylene glycol (20%), which in turn is used in fiberglass-reinforced plastics, foods, cosmetics, pharmaceuticals, cigarette tobacco, packaging materials, dyes, and hydraulic fluids. Propylene oxide is also used in the preparation of glycol ethers (3%); dipropylene glycol (2%); industrial polyglycols, lubricants, surfactants, oil demulsifiers, isopropanolamines, and as a solvent and soil sterilant (6%); approximately 9% was for export (Chem. Mktg. Rep., 1987a; Chem. Prod., 1984c; Merck, 1983).

Propylene oxide is also used in fumigation chambers for the sterilization of packaged foods; as a stabilizer for methylene chloride, fuel, and heating oils; in treating wood for termite resistance; as an acid scavenger and pH control agent; for removing residual catalysts from crude polyolefins; in fuel-air explosives in munitions; and as a component of Zeospan, a polyether

rubber (Kirk-Othmer V.19, 1982; Chem. Week, 1986d). The remainder of the propylene oxide produced in the United States is exported (Chem. Mktg. Rep., 1987a).

PRODUCTION

Chemical Engineering News ranked propylene oxide 36th among the top 50 chemicals with the highest production volumes (3.2 billion lb) in 1990 (Chem. Engr. News, 1987). The USITC identified two producers of propylene oxide in 1989, but no production volumes were reported (USITC, 1990). An estimated 1.5 million lb of propylene oxide were imported in 1989 (USDOC) Imports, 1990). An estimated 2.5 billion lb of propylene oxide was produced domestically in 1988 (Chem. Prod., 1988). The USITC identified two producers of propylene oxide in 1988, but no production volumes were reported (USITC, 1989). An estimated 2.6 billion lb of propylene oxide was produced in 1987 (Chem. Prod., 1988). In 1986, two U.S. companies produced propylene oxide (USITC, 1987). The Chemical Marketing Reporter identified two U.S. producers of propylene oxide for 1989, but no production data were reported (Chem. Mktg. Rep., 1990). Chemical Engineering News ranked propylene oxide 38th among the top 50 chemicals with the highest production volumes (2.48 billion lb) in 1986 (Chem. Engr. News, 1987). Another source estimated 2.3 billion lb of propylene oxide were produced that year (Chem. Prod., 1988). In 1983, two domestic firms produced an estimated 1.8 billion lb of propylene oxide (Chem. Mktg. Rep., 1987a; SRIa, 1985). In 1979, approximately 2.2 billion lb of propylene oxide were produced in the United States (SRIa, 1985; USDOC Imports, 1981). The 1979 TSCA Inventory included three manufacturers reporting a combined 1977 production of between 700 million and 1,700 million lb and two other manufacturers reporting no data (TSCA, 1979).

Propylene oxide imports for 1987 were estimated at 17 million lb and about 265 million lb were exported (Chem. Prod., 1988). It is estimated that 28 million lb of propylene oxide were imported and 200 million lb exported in 1986 (Chem. Prod., 1988). U.S. exports of propylene oxide dropped more than 20% from the 248.3 million lb exported in 1985 (USDOC Exports, 1986; Chem. Week, 1986b). The U.S. imported 23.7 million lb of propylene oxide in 1985 (Chem. Week, 1986b). The U.S. exported 146 million lb and imported 51 million lb of propylene oxide in 1982. In 1977, 99 million lb of propylene oxide were exported and 35 million lb were imported into the United States (SRIa, 1985).

The demand for propylene oxide is a function of the demand for its end products, which is tied to the economy. This may explain, in part, the drop in demand for propylene oxide in the early 1980s. Assuming that the economy remains stable, however, future demand for propylene oxide is expected to increase moderately at an average annual rate of 4% (Chem. Mktg. Rep., 1987a; SRIa, 1985; USDOC Imports, 1981). It has been estimated that total worldwide demand for propylene oxide exceeded 5.6 billion pounds in 1987. Trade sources estimate that world demand will increase an average of 4% annually for the next 5 years, representing an increase of 1 billion lb (Chem. Prod., 1988).

EXPOSURE

The primary routes of potential human exposure to propylene oxide are inhalation, ingestion, and dermal (especially eye) contact. In atmosphere it reacts with photochemically produced hydroxyl radicals (half-life 30 days). It is susceptible to leaching in soil and hydrolyzes in moist soil or water. The skin irritation hazard of propylene oxide is high. Consumer exposure may occur through ingestion of propylene oxide residues in foods from its

uses as an indirect food additive and as an adjuvant for pesticide chemicals. Occupational exposure of workers to propylene oxide may occur through inhalation or dermal contact mostly during its uses in the production of polyurethane polyols and propylene glycol. Time-weighted average exposures to propylene oxide at a production plant ranged from 0.2 to 2.0 ppm. Peak air concentrations ranged from 10 to 3,800 ppm propylene oxide, with the highest exposure occuring during maintenance (NIOSH, 1989). The 1987/1988 American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV), time-weighted average (TWA) is 20 ppm. The National Occupational Exposure Survey (1981-1983) indicated that 194,342 workers including 147,968 women, potentially were exposed to propylene oxide (NIOSH, 1984). This estimate was derived from observations of the actual use of the compound (6% of total observations) and the use of trade name products known to contain the compound (94%). The National Occupational Hazard Survey, conducted by NIOSH from 1972 to 1974, estimated that 268,433 workers potentially were exposed to propylene oxide. This estimate was derived from observations of the actual use of the compound (11% of total observations), the use of tradename products known to contain the compound (21%), and the use of generic products suspected of containing the compound (67%) (NIOSH, 1976). The Toxic Chemical Release Inventory (EPA) listed 121 industrial facilities that produced, processed, or otherwise used propylene oxide in 1996 (TRI, 1999). In compliance with the Community Right-to-Know Program, the facilities reported releases of propylene oxide to the environment which were estimated to total 6.4. million lb.

REGULATIONS

EPA regulates propylene oxide under the Clean Air Act (CAA), Clean Water Act (CWA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Food, Drug, and Cosmetic Act (FD&CA), Resource Conservation and Recovery Act (RCRA), and Toxic Substances Control Act (TSCA). CAA has set standards of performance for propylene oxide leaks in industry. CWA and CERCLA have established a reportable quantity (RQ) of 100 lb for propylene oxide, subjected it to handling and reporting requirements, and designated it as a hazardous substance. Propylene oxide is exempted from tolerances for residues in or on raw agricultural commodities, and is recognized as a toxic inert ingredient in pesticides under FD&CA. Propylene oxide is subject to permitting regulations under RCRA. The Interagency Testing Committee (ITC) has recommended testing for propylene oxide under TSCA. Developmental testing by manufacturers and processors is presently required. FDA regulates propylene oxide as an indirect food additive in products which may come into contact with food and as an adjuvant for pesticide chemicals. OSHA has set a final rule of permissible exposure limit (PEL) $\leq$ 20 ppm as an 8-hr time-weighted average (TWA) for propylene oxide and regulates it as a hazardous chemical in laboratories. NIOSH recommends that propylene oxide be considered a potential occupational carcinogen in conformance with the OSHA Cancer Policy (NIOSH, 1989). OSHA regulates propylene oxide under the Hazard Communication Standard and as a chemical hazard in laboratories. Regulations are summarized in Volume II, Table B-129.